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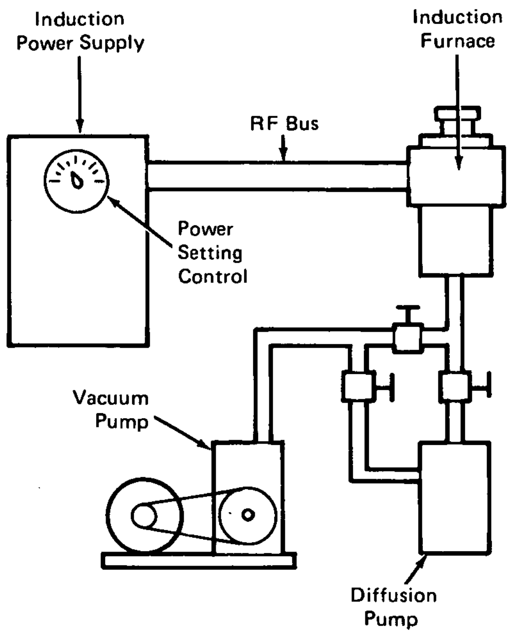
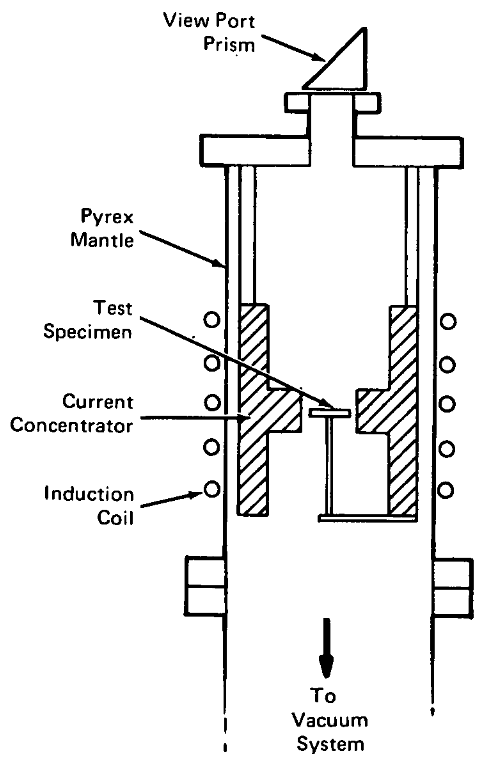
NASA TECH BRIEF

Space Nuclear Systems Office

Simple, Reproducible Methods for Thermal Shock Testing of Brittle Materials



APPARATUS



INDUCTION FURNACE

The problem:

The screening of prospective brittle materials for the Nuclear Rocket dictated the need for a thermal shock test which was quick, uncomplicated, and did not require a complete evaluation of the material's mechanical or thermal properties. Various single-cycle thermal-shock tests existed, but were generally difficult to control. They could not be used satisfactorily for carbide composites and graphites which represent about fifty percent of all brittle materials.

The solution:

A technique has been developed which induces thermal shock testing of brittle materials using radio-frequency power, without mechanical restraint of the specimen.

How it's done:

Only three pieces of equipment are required: a radio-frequency (rf) induction power source, an induction furnace, and a reasonably good vacuum system to prevent specimen oxidation during heating. The most important of the three is the power source (400 kHz at 50 kW), with "hard-start" characteristics since "soft-start" generators do not reach full power rapidly. Because the highest current density occurs at the outer diameter of the test specimen immediately adjacent to the concentrator, most of the heating occurs within a very thin peripheral layer of the specimen. Power re-

(continued overleaf)

mains on until fracture occurs or until a steady-state radial temperature is established. The steady-state condition takes place in about 2 seconds; fractures occur in about 1/2 second. The instant of fracture is determined by an acoustic wave emission device attached to the furnace. Seven samples have been run on each of 20 different materials in 6 hours with excellent reproducibility. In contrast, previous testing involving thermal conductivity would have required one week over a range of temperatures for a single sample of one material.

The technique is useful for virtually all materials, except those which are good electrical insulators, such as glass, since adequate rf coupling cannot be induced into them. An above average high school student could be trained to run repeatable tests in about two hours.

Note:

Requests for further information may be directed to:
Technology Utilization Officer
AEC-NASA Space Nuclear Systems Office
U.S. Atomic Energy Commission
Washington, D.C. 20545
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Patent Status:

No patent action is contemplated by the AEC or NASA.

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